Design Studies for the First Compressor Beamline for the Femtosecond X-Ray Source

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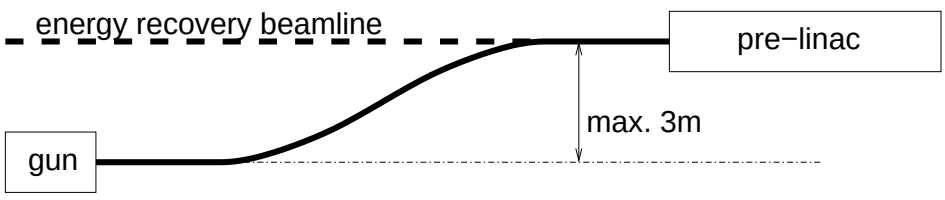
1 Introduction

The beamline for the first compressor serves two purposes:

- compress the bunch length from 20 ps to 10 ps
- offset the path of the beam sideways to allow a higher energy beam to enter the pre-linac in a straight line (for an energy recovery upgrade)

Schematic layout of the compressor beamline



Compression

- to obtain compression, R_{56} needs to be 0.72 m
- preferably just get it from the bending
- no ideal position for dedicated compressor
- if possible, R_{56} should be adjustable
- space restrictions
- bending radius should be about 1.5 m to avoid CSR

Magnets

- 10 cm long quadrupole magnets with $|k| < 40$
- 30 cm long dipole magnets with 10° bending angle corresponding to about 1.7 m bending radius

Lattices that were Tried

1. Double Bend Achromat
2. Triple Bend Achromat
3. Triple Bend Achromat with split magnet
4. FODO with missing magnet
5. dedicated compressor

Double Bend Achromat

- simplest lattice to achieve zero dispersion at both ends
- only small number of quadrupole magnets, therefore not very flexible
- only studied briefly and no solution found in that time

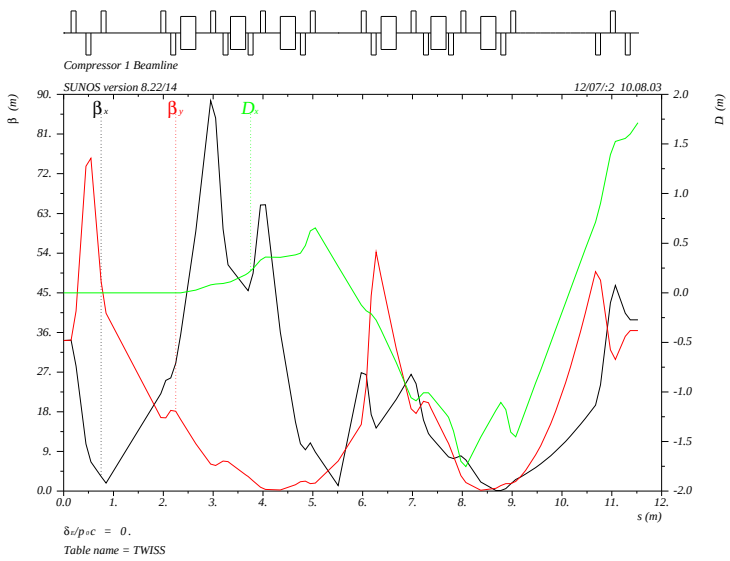
Triple Bend Achromat

- first a classical TBA was tried
- started with true achromat but allowed to change quadrupole strengths to match all boundary conditions
- it was tried to keep the lattice as symmetric as possible
- even with dropping all symmetry conditions, only small values of R_{56} were obtained

Triple Bend Achromat II

- introduce one more quadrupole in between bending magnets
- get large enough R_{56}
- two problems:
  1. large derivative of the dispersion at one end of the line
  2. very small β-functions at several places

Typical result using Triple Bend Achromats



Triple Bend Achromat with Split Magnet

- use two 10° and two 5° bending magnets in the second TBA instead of three 10° magnets in order to get a more asymmetric lattice
- all permutations of magnets were tried
- no solution found as problems persisted

FODO with Missing Magnet

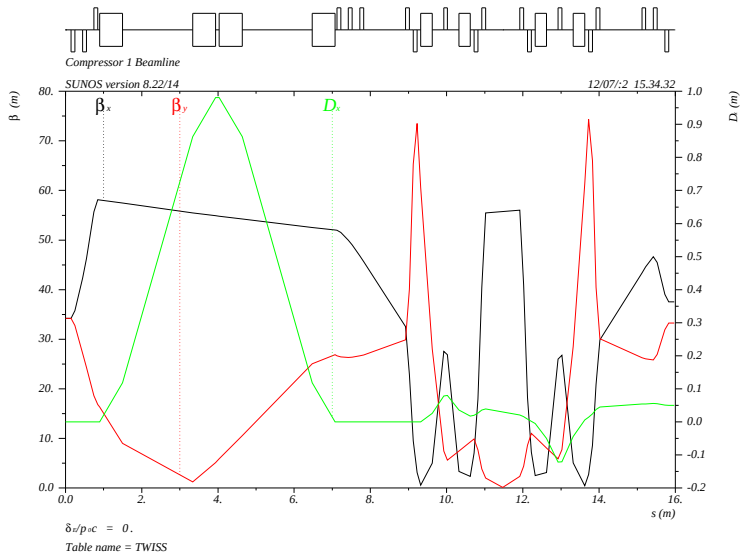
- F B D F B D B F
- missing magnet scheme can produce fairly large dispersion
- if dispersion was and dispersion prime were zero at the ends (required), R_{56} was small or the space requirements were not fulfilled

Dedicated Compressor

- try to use same bending magnets as for bending sections
- located before bending section
- first design just the compressor, than add the bending section
- for larger bending angles use 60 cm bending magnets

bending angle (in rad)	compressor length[a]
0.2	19.3 m
0.3	9.3 m
0.4	5.8 m

[a] The length is measured from the center of the first bending magnet to the center of the last bending magnet with the centers of the center magnets being 1 m apart.



Summary and Outlook

- different options for the beamline were studied
- the large required R_{56} can only be realized by a dedicated compressor
- compressor lattice needs some fine tuning
- study a compressor with a tunable R_{56}
- CSR studies need to be done